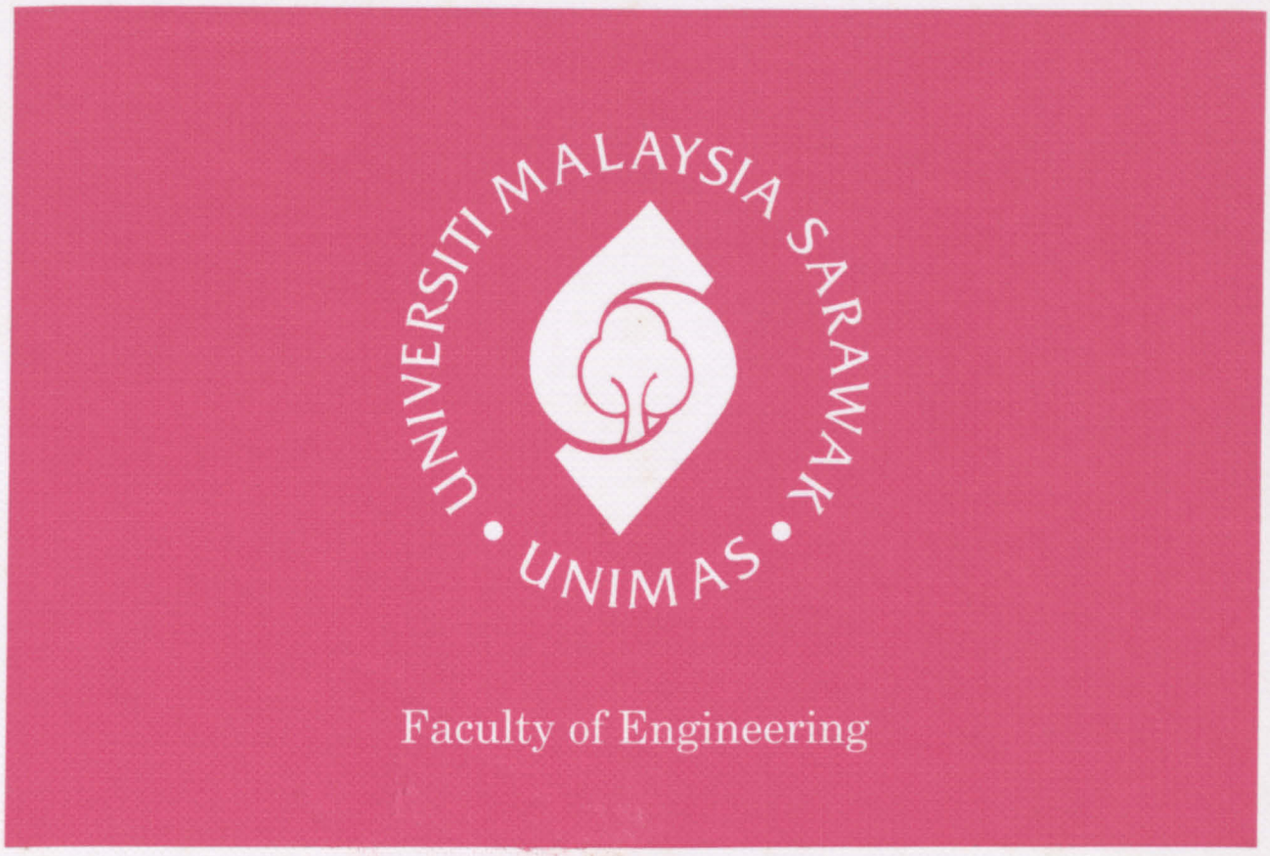

DESIGN AND FABRICATION OF A SOLAR POWERED RICE COOKER OR BANANA DRYER

Then Kuck Shee

Bachelor of Engineering with Honours
(Mechanical Engineering and Manufacturing Systems)
2004

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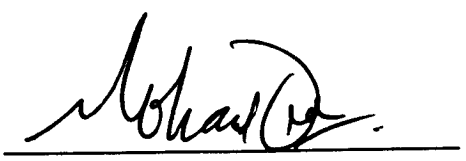

Dr. Mohd. Omar bin Abdullah

(Project Supervisor)

Date: 4 Mac 2004

DESIGN AND FABRICATION OF A SOLAR POWERED RICE COOKER OR BANANA DRYER

Then Kuck Shee

This project is submitted in partial fulfilment of
the requirements for the degree of Bachelor of Engineering with Honours
(Mechanical Engineering and Manufacturing System)

Faculty of Engineering
UNIVERSITI MALAYSIA SARAWAK
2004

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ABSTRAK

"Solar cooker" adalah mudah dan senang dihasilkan. Walau bagaimanapun, ia sememangnya wujud dan berfungsi. Ia boleh dihasilkan dengan pelbagai jenis bahan bergantung kepada kerperluan atau kehendak kita. "Solar cooker" adalah salah satu contoh yang baik dalam konteks "Technology Bersesuaian". Terdapat ramai NGO's dan perbadanan antarabangsa yang sedang mereka bentuk, menghasilkan dan menggunakan alat memasak yang mudah, tampan dan efektif ini. Sebuah "solar cooker" telah direka bentuk, dihasilkan dan diuji di Universiti Malaysia Sarawak (UNIMAS) sebagai Projek Tahun Akhir saya. "Solar cooker" yang dihasilkan diuji dengan 3 cara atau kaedah yang berlainan. Reka bentuk yang berlainan telah pun diuji. Hasil ujian menunjukkan bahawa "solar cooker" yang dilengkapi dengan dwi-lapisan plastik dan penyerap haba (tray yang berwarna hitam) di bahagiaan bawah " memberi bacaan suhu yang paling tinggi. Kombinasi yang optimum ini telah menghasilkan bacaan suhu sebanyak 89% lebih tinggi daripada kombinasi yang normal. Suhu memasak 87.5% telah dicapai dalam masa 2 jam selepas ujian dijalankan. Walaupun kenaikan suhu ini menampakkan sedikit kesukaran untuk mendidihkan air, namun suhu ini adalah sesuai dalam mengeringkan kebanyakkan makanan, memasak dan mahupun mongeringkan baju.

ABSTRACT

Solar box cookers are simple. But they are real, functioning appliances that can be made of many different things depend on our requirements or needs. Solar cookers are perfect example of appropriate technology. There are many NGO's and other groups worldwide now designing, constructing and using these simple, elegant and effective devices. A solar box cooker is designed, constructed and tested at Universiti Malaysia Sarawak (UNIMAS) as my "Projek Tahun Akhir". The solar box cooker is tested by using 3 different setups or methods. Various design changes were examined. Results show the advantages of double glazing and black absorption plates in the base of the cooker. The optimum combination of these changes resulted in an increase of 88% in cooking power compared to the basic design. Cooking temperatures of 87.5°C were reached within two hour. These temperatures and heating rates allow practical cooking of many foods. Solar cookers are also can be use to dye clothes, sterilize medical supplies, stored/dry food and even soil.

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CHAPTER 1

INTRODUCTION OF SOLAR COOKING

1.0 Introduction

We live in a rapidly changing world. Technology has an ever-increasing influence on our everyday lives. While some of us benefit, the majority of the worlds' people don't. The world is on the brink of environmental collapse, and we look again to technology to find answers to these growing problems.

Solar energy is the primary and the most importance source of energy for our Planet. During one day, the sun sends 10.000 to 15.000 times more energy onto the earth than we use. Increased utilization or optimizing the usage of the solar energy result in an all-round benefit, both in terms of cleaner environment and monetary gain, for the individual users as well as the nation. Use of solar energy would save a lot of time and money for the user and this could be effectively diverted for increased productive activities and monetary gains which mean better living standards and overall prosperity.

In areas where sunshine is plentiful and conventional fuels are expensive, the solar cooker is an ideal complement to a regular stove. It is cheap, easy to use and requires no fuel. The cooker works by concentrating the power of the sun onto a small area in which a pot or other implement is placed. Under strong sunlight, a liter of tap water can be brought to a rolling boil in about 10 minutes.

The solar cooker consists of 3 main parts. Reflector serves that is use to concentrate the sunlight a specified area or the location of our cookware. The control arm allows the reflector to be set facing the sun and holds the pot at the focal point regardless of the reflector tilt angle (for the parabolic type of cooker). The stand holds the other two components together and allows the cooker to be rotated to follow the sun as it moves across the sky (for the parabolic type of cooker).

1.1 The History of Solar Cooking [1]

In the earliest time of human existence, the method of food cooking was unknown. Human just ate the food in uncooked condition. Then people found that the existence of fire, started to control it and used it to cook food. For our knowledge, fire is essentially solar power that stored in the form of food. If we look at this way, solar cooking was the first method whereby human being used to cook food.

The first person to build the solar cooker was Horase de Saussure, a swish naturalist. He used a primitive solar cooker to cook fruits at the temperature of 190°F. So, he also had known for "The Grandfather of Solar Cooking".

During this time, others also started to create variety type of solar cookers. In India, a British soldier has created a quite sophisticated solar cooker that looked a lot like a solar chef. In 1894, there was a restaurant in China that came out with solar cooked food to serve their customers. There are also stories about a sea captain who created a solar cooker for his long voyages.

Early the 1950', the United Nations and many others funding agencies initiated and sponsor many studies to design a solar cooker that could be used to replace fuel as the main resources to cook food. As the result, many top engineers around the world were hired to study the different aspects in solar cooking design in 1950'. These studies concluded that properly constructed solar cookers not only cooked food thoroughly and nutritiously, but were quite easy to make and use.

After few years, the UN had sponsored studies and programs to introduce this solar cooking method into cultures where the need of solar cooker was most apparent. But unluckily, the task that carried out by UN was a failure. In one study, 500 wooden solar cookers were given to a refugee camp. Three months later they had been chopped up and used for firewood. The social scientist concluded that traditional cooking methods were too culturally ingrained, and people were unwilling to adapt.

However, the UN did note a success in the northern Mexican community that lack of fuel wood. The UN scientist found that the solar cookers provided were still in used even after 5 years. This showed that it was possible to get cookers out to people in need.

In spite of this success, the UN concluded that the solar cooker was not a viable option and all funding and sponsors were stopped. Many that involved with this early effort concluded that the studies themselves were flawed. They felt the designs being promoted were too complicated. Also, the cookers were too expensive for the intended users. They felt that more work was needed on the cooker designs. A few of them kept the potential of solar cookers alive by continuing to develop them in their own sunny backyards.

Others felt that the techniques promoted by the UN were also flawed. Social scientists, who had never integrated solar cooking into their own lives, were in charge of the UN studies. The cookers were promoted as a solution to poor people's problems, but certainly not as cooking tools that would be useful in developed countries. This caused solar cookers to be looked upon as a second class tool by those being asked to use them. Solar cooks sought new ways to promote solar cookers that were more sensitive to the cultures they were trying to share them with.

Although the UN had stopped the funding and sponsors in the development of solar cooker, people still keep developing their own simple solar cooker as a backyard hobby. Instead, people are sharing a tool that they themselves enjoy using. This is a great maturation within the solar cooking movement. It is also the reason we are now on the verge of a new growth cycle. The future story of solar cooking is wide open.

1.2 Type of Solar Cooker

The available designs of solar ovens fall into three main categories:

- Box
- Parabolic
- Panel designs.

The feature common to each oven design is the shiny reflective surface that directs the sun's rays onto a dark cooking vessel (cookware). Each category has its advantages and disadvantages when compared on their heating ability, ease of construction, ease and safety of use.

1.2.1 Box Cookers

Box cookers are the most common type made for personal use. Despite the name "box" cooker, they are made in both circular and rectangular shapes. Figure 1.0 illustrates the basic of box cooker design. They consist of an enclosed inner box covered with clear glass or plastic, a reflector, and insulation. There is a wide variety of patterns and plans that can be adapted to work with available materials. The main disadvantages for box cooker are they do not heat quickly, they provide slow, even cooking. But, box cookers are very easy and safe to use, and fairly easy to construct.

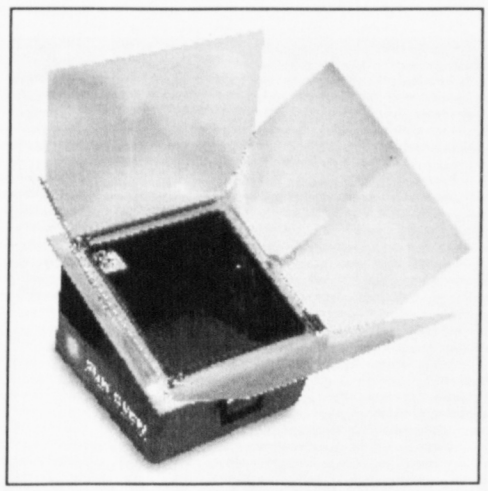

Figure 1.0 The basic design of solar box cooker

1.2.2 Parabolic Cookers

Parabolic cookers reach higher temperatures and cook more quickly than solar box cookers, but are harder to make and use. Most commercial cookers, such as the Solar Chef are a form of parabolic cooker. Parabolic cookers require more precision to focus the sunlight on the cooking vessel. If the sunlight is not focused exactly on the cooking vessel, the food will not cook. When the parabolic oven is used, the temperature must be watched so the vessel does not overheat, burning the food. The risk of burns and eye injury is greater with homemade parabolic designs. While they provide excellent results when used correctly, they are not easy to build at home and require great care to use (figure 1.1)

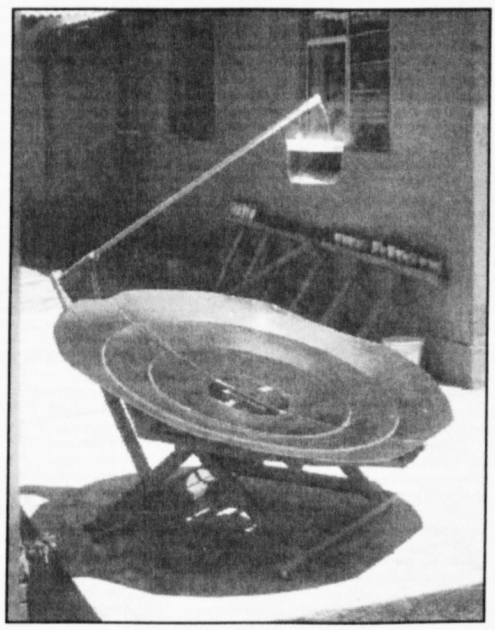

Figure 1.1 The basic design of a parabolic cooker

1.2.3 Panel Cookers

Panel cookers are flat reflective panels which focus the sunlight on a cooking vessel without the inner box common in box cookers. Panel cookers are the easiest and least costly to make, requiring just four reflective panels and a cooking vessel, but they are unstable in high winds and do not retain as much heat when the sun is hidden behind clouds. Figure below shows a panel cooker with dark cooking vessel and thermometer wrapped in a plastic oven bag (figure 1.2).

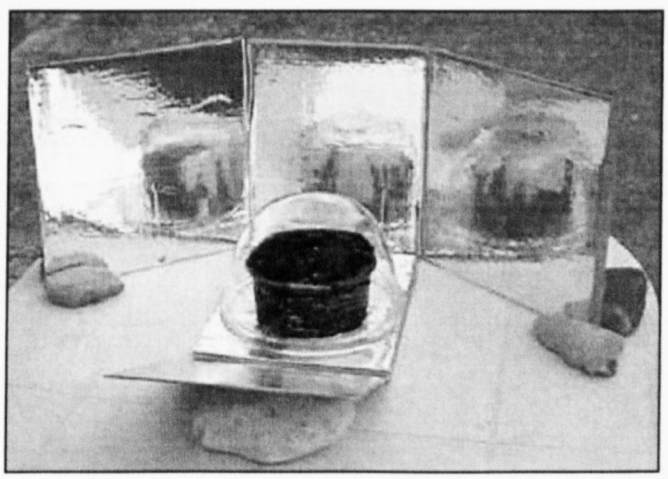

Figure 1.2 The basic design of panel cooker

1.3 Goal

To design and fabricate a solar rice cooker

1.4 Objective

The main objectives of conducting this project are:

- Literature review – to find out the rich area of solar rice cooker and parameters that influence the cooking performance.
- Design a solar rice cooker.
- Fabricate of a solar rice cooker.
- Data measurement, data collection and prototype testing.

1.5 Methodology of Research

The project is involving some method to make it more precise and concise, these include:

- Learn and Research – Considerate the solar intensity, heat transfer, heat gain, heat loss, material selection and etc.
- Experiments and testing – to find out the various effects of parameters.
- Calculations – Calculation of heat gain, heat loss, heat transfer and etc.
- Analytical Method: